SECURITY THREAD

This invention relates to a security thread for protecting documents, banknotes, or identification cards against forgery.

In banknotes, it is common to find security threads in the form of thin strips imbedded in paper, such strips of a magnetic material provided with magnetic coding. The strip may be provided with a metallised layer either side of the magnetic material, the metallisation also used to print fine characters as a further security feature. As mechanical support and protection, the magnetic material and metallisation layers are sandwiched between plastic (polyester) layers.

It is also known to provide piezoelectric film in security documents as described in US 4,763,927 or US 4,792,667, the presence of piezoelectric material being detectable by mechanical or pyroelectric testing means. In US 4,792,667, pre-poled films of polymeric material made from polyvinylidene fluoride (PVDF) or other polymeric piezoelectric materials are fixed to documents for security. Piezoelectric films with poled regions may not provide sufficient security for certain documents such as banknotes.

It would be desirable to further enhance the security against forgery of security threads. It would also be advantageous to provide additional features in a security thread that enable easy detection or that provide a redundant control in the event the primary security feature is defective. It is desirable to provide security means that are well adapted for manufacture in large quantities, and which are cost-effective to manufacture whilst enhancing security against forgery, reliability, and ease of detection.

It is an object of this invention to provide an improved security thread with enhanced security against forgery and ease of detection.

Objects of this invention have been achieved by providing the security thread according to claim 1. Disclosed herein is a security thread comprising a magnetic layer sandwiched between protective layers, wherein at least one of the protective layers is a piezoelectric polymer. Advantageously therefore, a particularly compact and cost-effective security thread is provided with enhanced security features. The magnetic material may be coded as is typical for conventional security threads, wherein the piezoelectric polymer layer may also have a series of juxtaposed poled and unpoled regions. The poled and unpoled regions may form a binary code such that both the magnetic and the piezoelectric layers have coding means; the magnetic layer being readable by a magnetic head, and the piezoelectric layer readable by a conductor or capacitive receptor after stimulation of the piezoelectric poled regions by mechanical (e.g. ultrasound) or pyroelectric (e.g. infrared rays) transmitters. On either side of the magnetic layer, there may be provided a metallisation layer, one of the metallisation layers thus being sandwiched between the magnetic layer and the piezoelectric layer and forming an electrode for the piezoelectric poled regions, in particular forming the ground electrode. The metal layer is reflective to light thereby concealing the magnetic layer, and forms a base for printing characters that can be read when light is passed through the metallisation layer. Compound security measures can thus be provided in a particularly compact security thread, requiring various detection means that enhances security against forgery.

Further advantageous aspects of the invention are set forth in the claims, or will be apparent from the following description and drawings.

Embodiments of this invention will now be described by way of example, with reference to the figures in which;

Figure 1 is a cross-sectional view through a security thread according to this invention, the thread shown partially laminated;

Figure 2 is a view similar to Figure 1 different embodiment according to this invention.

Figure 3 is a simple schematic view representing dipoles in a portion of piezoelectric layer taken in cross-section; and

Figure 4 is a simple schematic view illustrating how a piezoelectric layer is polarised.

Referring to Figure 1, a security thread 2 is shown in longitudinal cross-section. The security thread may be of substantially similar shape and dimension as a conventional security thread embedded in banknotes or security documents, for example in the form of a thin elongate thread traversing a banknote. The security thread 2 comprises a magnetic layer 4 sandwiched between polymeric layers 6, 8 either side of the magnetic layer 4. The polymeric layers 6, 8 may be of different materials, for example a first layer 6 being of simple polyester or other flexible plastic material, and the second layer 8 being of a piezoelectric material such as polyvinyldene fluoride (PVDF) or other piezo electric polymeric material. It is also possible to provide the second layer 8 as a simple flexible plastic layer such as polyester, coded or printed on one side thereof with a piezoelectric material such as polymer(VDF/TrVE) or vinylidene/tetrafluoritheylene co-polymer (VDF/TFE).

The flexible polymeric layers 6, 8 are also protective layers that support and protect the magnetic layer 4 therebetween from mechanical damage. The magnetic layer 4 may be coded magnetically along its length (direction L) such that each security thread has a distinctive magnetic code readable by a detection device having a magnetic head. The magnetic layer 4 is shown in Figures 1 and 2 as a layer separately laminated between the polymeric layers 6, 8, but the magnetic layer may also be printed or deposited otherwise on one of the polymeric support layers 6, 8, for example the simple polymeric (polyester) layer 6. The polymeric layer 6 with the deposited magnetic layer 4 would then bonded to the other polymeric layer 8 by means of a conventional adhesive.

A metallisation layer 10 is provided between the magnetic layer 4 and the piezoelectric layer 8. The metallisation layer 10 may be deposited on the piezoelectric layer 8 by sputtering or other conventional metal deposition methods for deposing metals on substrates or the like. The metallisation may also be etched in certain places to form characters that are readable when light is shone through the security thread. The electrode 10 further acts as a ground electrode for contacting an inner side 11 of the piezoelectric layer 8 to ground, the opposing other side 12 of the piezoelectric layer 8 being readable by a detection device, for example a conductive member biased thereagainst. When subject to mechanical deformation, piezoelectric material produces electrical charges, an electrical potential thus being developed between the inner and outer layers 11, 12. The electrical charge that develops can either be read by an electrical detector connected to the ground electrode 10 and the charge

electrode layer 12, or by capacitive detection means that responds to the electrical field created by the electrical charges. Piezoelectric materials such as PVDF also have a pyroelectric effect, whereby when subject to heat (for example from a light source emitting infrared) the heating of the piezoelectric creates an electric potential between the opposed layers 11, 12. Detection of the pyroelectric effect may for example be effected by the detection device described in International Application WO 97/07478.

As shown in Figure 1, the polymeric layer 6 may also be provided with a metallisation layer 14 on its inner side 15. This metallisation layer may similarly be provided with characters.

In the embodiment of Figure 1, the piezoelectric layer 8 is substantially uniformly charged (poled) piezoelectrically along the whole length thereof. As illustrated in Figure 2, in a second embodiment the piezoelectric layer 8 is provided with a series of poled regions 16 and unpoled regions 18. The poled and unpoled regions may have lengths that are multiples of a smallest bit length, as depicted in Figure 2 by the poled region 19, such that the piezoelectric layer 8 has a binary code extending along its length L. By mechanical excitation such as ultrasound, a conductive or capacitive detector can pick up the electrically charged areas along the length, thereby reading the binary code.

It is also possible to charge piezoelectric material such as PVDF, either negatively or positively such that certain of the poled regions are positive and certain of the poled regions are negative. In this way, it is also possible to provide a tertiary code rather than a binary code. The latter is illustrated in Figure 4 which schematically illustrates the dipole orientation in a

portion of polymeric piezoelectric layer. The horizontal dipoles 20 indicate a non-piezoelectric area and the vertical dipoles 21, 22 represent respectively negative and positively poled areas.

The coded piezoelectric layer 8 of the embodiment of Figure 2 can be made by positioning a ground electrode 24 against one side of the layer 8 (for example the metallised ground layer 10) and positioning charge electrodes 26 on the charge side 12 of the layer 8. The charge electrodes 26 may be provided with a high positive or negative voltage depending on whether positive poled regions or negative poled regions are desired. The charge electrodes 26 may be held together in a single structure, with a dieletric (such as a ceramic or air) separating the poling regions. The electrodes may be provided on a rotating drum, the grounded electrode forming a opposed rotating drum with the piezoelectric layer sandwiched therebetween such that a continuous lamination of the piezoelectric layer 8 with piezoelectric poling can be effected.

As illustrated in Figure 2, the first polymeric layer 6 may also be a piezoelectric layer, for example charged with a binary code that may either differ from the binary code of the layer 8 as indicated by the piezoelectric charged regions 16' and immediate non-charged regions 18'. It is also possible to provide the first layer 6 with the same binary code as the second layer 8 to enhance the reliability in the event one of the layers is defective. The second metallisation layer 14 could also act as the ground electrode for the piezoelectric layer 6 in a similar manner to the ground electrode for the piezoelectric layer 8.

A particularly compact security thread with enhanced security is thus provided. The means of detecting the

security thread based on different physical effects such as the magnetic field of the magnetic layer 4 and the electrical field or potential differences of the piezoelectric layer or layers 6, 8, significantly increases difficulty of forgery.